Thermodynamics and Thermochemistry



(a)	40 <i>kJ</i>	(t)	> 0 <i>kJ</i>

- (c) $< 40 \ kJ$ (d) Zero
- **2.** The correct relationship is
 - (a) $\Delta H + P\Delta V = \Delta V$ (b) $\Delta H \Delta nRT = \Delta E$

[DPMT 2002]

- (c) $\Delta E + \Delta nRT = \Delta P$ (d) None of these
- 3. For $CaCO_3(s) \Rightarrow CaO(s) + CO_2(g)$ at $977^{\circ}C$; $\Delta H = 176 \ kJ$ mol, then ΔE is [BVP 2003] (a) 180 kJ (b) 186.4 kJ

(c)	165.6 <i>kJ</i>	(d)	160 <i>kJ</i>
· ·	- /		

4. Values of ΔH and ΔS for five different reactions are given below.

Reaction	$\Delta H(kJmol^{-1})$	$\Delta S(JK^{-1}mol^{-1})$
1	+98.0	+14.8
11	- 55.5	-84.6
111	+28.3	-17.0
IV	- 40.5	+24.6
ν	+ 34.7	0.0

On the basis of these values predict which one of these will be spontaneous at all tempeature

		[Kerala PMT 2004; KCET 1988,90]
(a)	Reaction 1	(b) Reaction 11
(c)	Reaction III	(d) Reaction IV

- (e) Reaction V
- 5. Molar heat capacity of water in equilibrium with ice at constant pressure is [11T JEE 1997]
 - (a) Zero (b) Infinity (∞)
 - (c) $40.45 \, kJ \, K^{-1} mol^{-1}$ (d) $75.48 \, J \, K^{-1}$
- **6.** Internal energy does not include
 - (a) Nuclear energy
 - (b) Rotational energy
 - (c) Vibrational energy
 - (d) Energy arising by gravitational pull
- Two moles of an ideal gas expand spontaneously into a vacuum. The work done is [AMU 2000]
 - (a) 2 *Joule* (b) 4 *Joule*
 - (c) Zero (d) Infinite
- **8.** Heat exchanged in a chemical reaction at constant temperature and constant pressure is called as

[BHU 1998; Pb. PET 2000; MP PET 2002]

[AIIMS 1999; CPMT 2000]

(a) Internal energy (b) Enthalpy

(c)	Entropy	(d) Free energy	
9.	Which of the following statements is true		[KCET 2002]
	(a) ΔE is a	always greater than ΔH	
	(b) ΔE is a	always less than ΔH	

Self Evaluation Test -10

- (c) ΔE may be lesser or greater or equal to ΔH
- (d) ΔE is always proportional to ΔH
- 10. Mass and energy are conserved is demonstrated by
 - [MH CET 2002]
 - (a) First law of thermodynamics(b) Law of conservation of energy
 - (c) Law of conservation of mass
 - (d) Modified form of 1 law of thermodynamics
- **II.** The enthalpy of the reaction,

$$\begin{aligned} H_2(g) + \frac{1}{2}O_2(g) &\to H_2O(g) \text{ is } \Delta H_1 \text{ and that of} \\ H_2(g) + \frac{1}{2}O_2(g) &\to H_2O(l) \text{ is } \Delta H_2. \text{ Then} \end{aligned} \qquad \textbf{[KCET 2004]} \\ \textbf{(a)} \quad \Delta H_1 < \Delta H_2 \qquad \textbf{(b)} \quad \Delta H_1 + \Delta H_2 = 0 \end{aligned}$$

(c)
$$\Delta H_1 > \Delta H_2$$
 (d) $\Delta H_1 = \Delta H_2$

12. A reaction occurs spontaneously if

[MP PET 2002; CBSE PMT 2005]

- (a) $T\Delta S < \Delta H$ and both ΔH and ΔS are +ve
- (b) $T\Delta S > \Delta H$ and both ΔH and ΔS are +ve
- (c) $T\Delta S = \Delta H$ and both ΔH and ΔS are +ve
- (d) $T\Delta S > \Delta H$ and ΔH is +ve and ΔS is -ve

 Which expression is correct for the work done in adiabatic reversible expansion of an ideal gas [AMU 2002]

(a)
$$W = nRT \ln \frac{V_2}{V_1}$$
 (b) $W = n_e \ln \frac{T_2}{T_1}$

(c)
$$W = P\Delta V$$
 (d) $W = -\int_{1}^{2} P dV$

 If an endothermic reaction is non-spontaneous at freezing point of water and becomes feasible at its boiling point, then

[AIEEE 2002]

- (a) ΔH is -ve , ΔS is +ve
- (b) ΔH and ΔS both are +ve

(c) ΔH and ΔS both are $-ve$	(a) $-68.0 kJ$
(d) ΔH is +ve, ΔS is -ve	(c) $68.0 kIm$
What is the entropy change (in $JK^{-1} mol^{-1}$) when one mole of ice 21.	Equilibrium cons
is converted into water at $0^{o}C$ (The enthalpy change for the	
conversion of ice to liquid water is 6.0 $k\!J{}^{mol^{-1}}$ at ${}^{0^oC})$ [CBSE PMT 2003]	(a) Standard fr
(a) 21.98 (b) 20.13	(b) Free energy
(c) 2.013 (d) 2.198	(c) Temperatur
One mole of $NaCl$ (s) on melting absorbed $30.5 kJ$ of heat and	(d) None
its entropy is increased by $\frac{28.8 J K^{-1}}{1.5}$. The melting point of	The standard (
NaCl is [DPMT 2004]	equilibrium cons
(a) 1059 K (b) 30.5 K	
(c) 28.8 K (d) 28800 K	(a) $K = -RT$
The enthalpy change (ΔH) for the process	(a) $\mathbf{R}_p = \mathbf{R}$
$N_2H_4(g) \to 2N(g) + 4H(g)$ in 1724 KJ mol ⁻¹ If the head	٨
$391 KI mol^{-1}$	(c) $K_p = -\frac{\Delta C}{R'_p}$
energy of $N-H$ bond in ammonia is . What is the	The standard en
bond energy of $N-N$ bond is N_2H_4	$58.04 \ kL$ and
[MP PMT 2004]	
(a) $160 \ KJ \ mol^{-1}$ (b) $391 \ KJ \ mol^{-1}$	The standard fre
(c) $1173 KJ mol^{-1}$ (d) $320 KJ mol^{-1}$	(a) $-5.38 \ kJ$
Liquid ammonia is used in refrigeration because of its	(c) $5.38 \ kJ$
24. [DCE 2003]	For the equilibri
(a) High dipole moment	
(b) High heat of vaporisation	(a) Standard fr
(c) High basicity	
(d) All of these	(b) Free energy
A cylinder of gas supplied by Bharat Petroleum is assumed to 14 ka 20 000 kI	(c) Standard fr
contain ¹¹⁷⁸ of butane. It a normal family requires ^{20,000,00} of energy per day for cooking, butane gas in the cylinder last for	(d) Standard free
Days [Kerala PMT 2004] 25.	For reaction A
$(\Delta H_c \text{ of } C_4 H_{10} = -2658 \text{KJ per mole})$	$\Delta H = 30.56$
(a) 15 days (b) 20 days	Temperature at

- (; (d) 40 days
- (c) 50 days
- (e) 32 days

15.

16.

17.

18.

19.

The heat of neutralization of HCl by NaOH under certain 20. condition is – 55.9 kJ and that of HCN by NaOH is –12.1 kJ. the heat of ionization of HCN is [MP PET 2001] Thermodynamics and Thermochemistry 453

- mol^{-1} (b) $-43.8 \, kJ \, mol^{-1}$
- ol^{-1} (d) $43.8 \, kJ \, mol^{-1}$

stant of a reaction is related to

[AIIMS 1991]

 $\Delta G'$

- ee energy change ΔG^o
- change ΔG
- re T
- Gibbs free energy change ΔG^o is related to [MP PET/PMT 1998] stant K_p as

(a)
$$K_p = -RT \ln \Delta G^o$$
 (b) $K_p = \left(\frac{e}{RT}\right)^{-1}$

c)
$$K_p = -\frac{\Delta G^o}{RT}$$
 (d) $K_p = e^{-\frac{\Delta G^o}{RT}}$

thalpy or the decomposition of N_2O_5 to NO_2 is standard entropy of this reaction is 176.7 J/K. e energy change for this reaction at $25^{\circ}C$ is [DCE 2004] (b) 5.38 kJ (d) -538 kJ

ium $H_2O(l) \rightleftharpoons H_2O(g)$ at 1 atm and 298 K

[AIIMS 2004]

- ree energy change is equal to zero $(G\Delta^o = 0)$
- change is less than zero $(\Delta G < 0)$
- ree energy change is less than zero ($\Delta G^o < 0$)

e energy change is greater than zero ($\Delta G^o > 0$)

 $Ag_2O(s) \rightarrow 2Ag(s) + (1/2)O_2(g)$ the value of $kJ \ mol^{-1}$ and $\Delta S = 0.066 \ kJK^{-1} \ mol^{-1}$. which free energy change for reaction will be zero, [MH CET 1999] is (a) 373 K (b) 413 K

(c) 463 K (d) 493 K



1. (d) $A \xrightarrow{\cdots} B$ A ← _____B

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$$\Delta H = 40 - 40 = 0 \; .$$

 $\Delta E = \Delta H + \Delta n R T$

- **2.** (b) $\Delta H = \Delta E + \Delta n R T$.
- **3.** (c) $\Delta n = 1 0 = 1$

$$\Delta E = +176 - 1 \times \frac{8.314}{1000} \times 1240 = 165.6 \, kJ.$$

- 4. (d) A spontaneous process is accompanied by decrease in enthalpy and increase in entropy means ΔH is negative and ΔS is positive.
- 5. (b) $C_P = \left(\frac{\delta H}{\delta T}\right)_P$, At equilibrium *T* is constant *i.e.* $\delta T = 0$, thus $C_P = \infty$.

6. (d)
$$E = E_{ele.} + E_{nucl.} + E_{chemical} + E_{potential} + E_{kinetic}(E_t + E_v + E_r)$$
.

- 7. (c) An ideal gas under going expansion in vacuum shows, $\Delta E = 0, W = 0$ and q = 0.
- **8.** (b) $\Delta H = q_p$.
- **9.** (c) ΔE may be greater or lesser or equal to ΔH .

$$\therefore \Delta H = \Delta E + P \Delta V = \Delta E + \Delta n R T.$$

- 10. (d) It is a modified form of 1st law of thermodynamics. It is a conservation law of mass and energy.
- **11.** (a) for reaction (i) $\Delta n_1 = 0.5$

for reaction (ii) $\Delta n_2 = 1.5$

- So, $\Delta H_1 < \Delta H_2$
- 12. (b) For spontaneous reaction ΔG should be negative $\Delta G = \Delta H - T\Delta S = (+ve) - T(+ve)$

If $T\Delta S > \Delta H$ then ΔG will be negative and reaction will be spontaneous.

- **13.** (b) $W = P\Delta V$.
- 14. (b) ΔH and ΔS both are +*ve* than reaction is spontaneous.

15. (a)
$$\Delta S = \frac{q_{rev}}{T} = \frac{6000}{273} = 21.98 \, JK^{-1} mol^{-1}$$

16. (a) $NaCl(s) \rightleftharpoons NaCl(l)$

Given that : $\Delta H = 30.5 \text{ KJ mol}^{-1}$ $\Delta S = 28.8 \text{ JK}^{-1} = 28.8 \times 10^{-3} \text{ KJ K}^{-1}$ By using $\Delta S = \frac{\Delta H}{T}$ $= \frac{30.5}{28.8 \times 10^{-3}} = 1059 \text{ K}$ H H

17. (a) H - N - N - H (So, 4N - H bond present)

means their energy $= 391 \times 4 = 1564$ so the bond energy of N - N in N_2H_4

=1724 - 1564 = 160 KJ / mol

 (b) Ammonia has high heat of vaporisation hence is used in refrigeration.

$$=\frac{\Delta H_c}{\text{mol. wt.}}=\frac{2658}{58}=45.8 \text{ KJ}/\text{gm}$$

Cylinder consist 14 Kg of butane means 14000 gm of butane

 $\therefore 1 gm$ gives 45.8 KJ

$$\therefore 14000 \, gm$$
 gives 14000×45.8

 $= 641200 \, KJ$

Family need 20,000 KJ/day

So gas full fill the requirement for
$$\frac{641200}{20,000} = 32.06 \, days$$

19.

21. (a) $\Delta G^o = -2.303 \log k$.

(d)
$$K_p = e^{-\Delta G^o / RT}$$

(d)

22.

23.

24.

25.

(b) For reaction $H_2O(l) = H_2O(g)$

 $\Delta n = 1$ means positive

so when Δn is positive then $\Delta G < 0$.

(c) $\Delta G = \Delta H - T\Delta S$ $\Delta G = 0$ at equilibrium $\therefore \Delta H = T\Delta S$ or $30.56 = T \times 0.066$ T = 463 K.